REMARKS

Introduction

In response to the Office Action dated July 11, 2008, Applicants have cancelled claims 1-8. Claims 9 and 10 have been amended. Care has been taken to avoid the introduction of new matter. In view of the foregoing amendments and the following remarks, Applicants respectfully submit that all pending claims are in condition for allowance.

Entry of Amendment under 37 C.F.R. § 1.116

The Applicants request entry of this Rule 116 Response. Dependent claims 9 and 10 have been rewritten into independent form including all of the limitations of claim 1. There are no new issues presented. As will be explained below, the claim amendments place the application in condition for allowance. Moreover, the Manual of Patent Examining Procedure sets forth in Section 714.12 that "any amendment that would place the case either in condition for allowance or in better form for appeal may be entered." Entry of these claim amendments is respectfully requested.

Claim Rejection Under 35 U.S.C. § 103

Claims 1-17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,313,392 to Sato et al. ("Sato") in view of U.S. Publication No. 2002/0026856 to Suzuki et al. ("Suzuki").

An aspect of amended claim 9 is a thermoelectric material having an average crystal particle size of at most 50 nm and having a relative density of at least 85 %, where the thermoelectric material comprises a composition of at least one of Fe, Zn, Co, Mg, Mn, Zr and

Ni and at least one of Si, O, Sb and Sn, or a mixture of at least two of the compositions. An aspect of amended claim 10 is a thermoelectric material having an average crystal particle size of at most 50 nm and having a relative density of at least 85 %, where the thermoelectric material comprises a composition of at least one of Fe, Zn, Mg, Mn, Zr and Ni and at least one of Si, O, Sb and Sn, or a mixture of at least two of the compositions.

In the Response to Arguments section, the Examiner contends that Sato specifically desires as small as possible particle size, which includes particles within the range of no more than 50 nm. The Examiner relies on Suzuki to teach that particle sizes of no more than 50 nm are known in the thermoelectric material art. The Examiner concludes that it would have been a modification obvious to one of ordinary skill in the art at the time the invention was made to select a range of particles known in the art from a broader range of desirable particle sizes that encompass this range.

Sato is *silent* regarding a thermoelectric material having an average crystal particle size of at most 50 nm and having a relative density of at least 85 %, where the thermoelectric material comprises a composition of at least one of Fe, Zn, Co, Mg, Mn, Zr and Ni and at least one of Si, O, Sb and Sn, or a mixture of at least two of the compositions, as required by amended claim 9. Further, Sato is *silent* regarding a thermoelectric material having an average crystal particle size of at most 50 nm and having a relative density of at least 85 %, where the thermoelectric material comprises a composition of at least one of Fe, Zn, Mg, Mn, Zr and Ni and at least one of Si, O, Sb and Sn, or a mixture of at least two of the compositions, as required by amended claim 10.

Suzuki is *silent* regarding a thermoelectric material having an average crystal particle size of at most 50 nm and having a relative density of at least 85 %, where the thermoelectric material comprises a composition of at least one of Fe, Zn, Co, Mg, Mn, Zr and Ni and at least one of Si,

O, Sb and Sn, or a mixture of at least two of the compositions, as required by amended claim 9. Further, Suzuki is *silent* regarding a thermoelectric material having an average crystal particle size of at most 50 nm and having a relative density of at least 85 %, where the thermoelectric material comprises a composition of at least one of Fe, Zn, Mg, Mn, Zr and Ni and at least one of Si, O, Sb and Sn, or a mixture of at least two of the compositions, as required by amended claim 10. Thus, Suzuki fails to cure the deficiencies of Sato.

As Suzuki and Sato do not disclose the same thermoelectric material as disclosed by the present inventors, and even if combined still fail to disclose or suggest the elements recited by amended claims 9 and 10, the combination of Suzuki and Sato does not render the thermoelectric material as recited by amended claims 9 and 10 obvious.

Further, the Examiner failed to provide requisite factual basis to support the motivation element, noting that the claimed particle size is functionally significant.

It is well known by persons skilled in the art that sintering requires an increase in pressure and that increase of the sintering pressure results in the increased density of a sintered body and the simultaneous growth of crystal grains. When nano powders obtained by the laser ablation method are sintered under high pressure, the formed sintered body of crystal grains cannot obtain a size on the order of nanometers due to the growth of crystal grains.

According to an aspect of the instant application, when powders are sintered under the high pressure of 1 GPa or more, the growth of crystal grains is restrained, which results in a thermoelectric material having an average crystal particle size of at most 50 nm and a relative density of at least 85 % (*see, e.g.,* pg. 9, lines 20-29).

The following Table A shows the relationship between the sintering pressure and the properties of the thermoelectric material, such as, the average crystal particle size and the relative

density. The data shown in Table A is extracted from Table 3 and Table 4 of the instant specification.

Table A: The relationship of the sintering pressure and the thermoelectric material's properties

No. (corresponding to the specification)	Sintering pressure (GPa)	Sintering temperature (°C)	Average particle size of sintered body (μm)	Relative density (%)	Relative electrical resistivity	Thermal conductivity (W/mK)
20 (Comparative Example)	0.1	1400	5	82	1.00	42
21 (Comparative Example)	0.8	1300	1.5	84	1.00	30
8 (Example)	1	900	0.05	89	1.00	10
9 (Example)	3	900	0.035	93	0.98	8
10 (Example)	5	820	0.023	96	1.03	4.8

In Examples 8-10 and Comparative Examples 20-21, powders of 5-10 nm are used as a raw material. However, in Comparative Examples 20-21, the crystal grains grow in the powders, and the average particle size is 1.5 or 5 μm, respectively.

On the other hand, in the instant case, as illustrated in Examples 8-10, the relative density increases while the growth of crystal grains is controlled to form sintered bodies having an average crystal particle size of at most 50 nm and the relative density of at least 85 %. Thus, Table A and the corresponding specification show that the growth of crystal grains is restrained, as the sintering pressure increases in the instant application.

Thereby, as taught in the instant specification, the performance of the thermoelectric material is represented by the thermoelectric figure of merit determined by the following expression:

$$Z = S^2 / (\rho \bullet \kappa)$$

where S is Seebeck coefficient (V/K), ρ is electrical resistivity (Ωm) and κ is thermal conductivity (W/mK) (*see, e.g.*, pg. 2, lines 1-5). Therefore, the performance of the

thermoelectric material in Examples 8-10 is approximately 4 to 9 times ***higher*** than Comparative Examples 20-21. However, Suzuki and Sato do not disclose or suggest this, and apparently are unaware of the unexpected improvement in reducing the average particle size of the sintered body and thermal conductivity made possible by the claimed thermoelectric material.

Conclusion

In view of the above amendments and remarks, Applicants submit that this application should be allowed and the case passed to issue. If there are any questions regarding this Amendment or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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